THE HISTOLOGY AND NERVOUS SYSTEM OF THE CALCAREOUS SPONGES.

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Like other Sponges, the Calcispongiæ consist of Entoderm, Mesoderm and Ectoderm. The Mesoderm is the only layer which is highly differentiated. Ectoderm and Entoderm are formed by a single layer of cells. The outer surface of the Sponge doubtlessly is Ectodermal and the cells which line the Oscular tube, the ciliated chambers and the excretary canal system can with equal certainty be determined as Entodermal. The Epithelium of the introductory Canals is in all probability in the greater part Ectodermal, in a small portion Entodermal.

ENTODERM.

The Entoderm is very simple, but nevertheless shows a higher development than the Ectoderm. In some Calcareous Sponges it consists of one kind of cells only; the ordinary flagellate elements with frills. In others again only part of the Entodermal Epithelium is composed of such cells, whilst another part consists of simple, low pavement cells. Where such a differentiation occurs, the flagellate fringe-cells are found in the outer and middle part of the body, lining the ciliated chambers or their homologa, whilst the pavement cells clothe the Oscular tube and the exhalent canals leading from the ciliated chambers to the Oscular tube.

Those Sponges, which Haeckel comprises in his Family Ascones, Leucosolenia Bowerbank, which possess a simple tube shaped gastral cavity and in which no ciliated chambers are developed, possess flagellate Entodermal cells only. The same is the case with an Australian Sponge which possesses ciliated chambers like the Syconidæ, recently described in these Proceedings.

I combine all these forms with non-differentiated Entoderm in one Group, for which I adopt Poléjaeff's term Homocœla, the meaning of which word I adapt to the view explained above.

All the other Calcareous Sponges possess a more highly differentiated Entoderm. Ciliated chambers clothed with flagellate cells are always present and the Oscular tube and adjacent canals are clothed with pavement cells. I combine all these to form one Group for which I likewise adopt Polejaefts term, Heterocoela the meaning of which word is likewise modified.

MESODERM.

The Mesoderm, which forms the bulk of the Sponge, consists of Gallert of a pretty high degree of density.

In this the Mesodermal cells are imbedded. In Calcispongiæ the Gallert never shows a fibrillous structure as is the case in some others Sponges. (Gumminæ.)

Also the Skeleton of these Sponges is produced by the Mesoderm. The spicules always originate there and are always clothed with Mesodermal cells or a Mesodermal cuticle, however far they may protrude beyond its limits.

THE TISSUE CELLS.

In all calcareous Sponges numerous starshaped cells, with a spherical nucleus, are found in all parts of the Gallert, their protoplasmic processes are slender and vary in number from three to ten. Generally they are simple, only exceptionally they may be ramified. These cells are different in different Calcispongiæ in as much as in some they are all alike with about five irregular processes, whilst in others we find different kinds of these star-shaped elements in the different parts of the body. The first is the case in the Homocœla, the second in the Heterocœlia. Here we find that in the central parts of the Mesoderm these cells have numerous irregularly disposed processes, whilst they attain a greater regularity towards the surface. The nearer they lie to any free surface the more all their processes are influenced thereby in such a manner that they run parallel to the surface in a more and more tangental direction. In most parts of the Sponge these processes at the same time diminish in number till we finally arrive at structures which no longer can be termed star-shaped, but which are already decidedly bipolar, spindle-shaped. Such bipolar tissue cells are very frequent in other Sponges. In the Calcispongiæ they are comparatively rare, and met with only in the Heterocœlia. They are here perhaps to be considered as muscular element throughout. It is in the Calcispongiæ still more difficult than in others to discern between contractile cells and ordinary tissue elements.

In the Homocoela the movements (closing of Pores) are doubtlessly caused by contractions of the Processes extending from the star-shaped tissue cells.

SKELETON.

Spicules, with two, three and four axis, comparable to the axis of crystals, are always found in great abundance in the Calcispongiæ. They consist of carbonate of lime, mixed with organic substance. They often protrude beyond the Mesoderm. But they are, as mentioned above, always covered by a mesodermal cuticule. The structure of the spicules can best be studied in specimens treated with chloride of gold-potassium. (Twelve hours.) By means of the appliance of this re-agent we see that the whole spicule consists of a great number of small prisms, parallel to one another, radiating from the axis. Under ordinary circumstances no such structure can be detected, but by the appliance of the gold solution we can readily isolate these prisms. A spicule exposed to this re-agent represents melting glacier ice in appearance. Like the latter it is composed of parallel prisms.

Furthermore we find that the radial structure first makes its appearance in the interior, close to the inner axis, which is a cylindrical chord of organic matter without lime. The whole spicule soon commences to be dissolved by the gold solution if the latter is strong, and always from the axis outward. The outermost layer remaining intact whilst the central parts are split up into prisms and dissolved. These new observations, together with those of other authors, point to the fact that the inner part, the part produced first, of the spicule is softer and contains more organic matter, whilst the outer layers, the youngest part, is harder and resists the action of re-agents ; the whole spicule is composed of prisms formed as cuticular productions by the cells clothing the spicule from without.

With colouring re-agents it is easy to prove the existence of a highly colourable cuticle all over the spicule. On the part of the spicules which protrude beyond the surface of the Sponge, the cuticle is easily rubbed off, but always present, if the Sponge is captured with sufficient care. The existence of a cuticle on the protruding part can be proved without observation : were there no cuticle the spicule would very soon be dissolved by the sea-water and traces of a corrosive action thereof are never met with, unless in those spicules found on the bottom of the sea or taken up by other Sponges or Foraminifera to help to build up their skeleton.

This cuticle is slowly converted into spicule substance by an interposition of molecules of carbonate of lime. This is the cause of the lamella-structure of the spicules. Outside the Mesodermal cuticle flat, Endothel-cells are met with, covering the immersed part of the spicule, in the shape of a hollow tube. Also on the protruding part of the spicules such cells can be detected, but I believe the latter to be Ectodermal, and nothing else than a continuation of the Ectodermal pavement Epithelium.

The spicules firstly make their appearance within cells, and the axial rod (not canal !) is part thereof. The succeeding layers are cuticular productions of Endothel cells.

It is remarkable that the rays of the spicules are often curved in various ways.

THE MUSCULAR CELLS.

Although all the tissue-cells, particularly in the Homocœla are to be considered as contractile, still there are some Mesodermal elements which are developed in such a manner that their muscular nature is much more expressed than in in the ordinary tissue cell.

I have met with the elements I refer to in the Syconidæ, around the regularly disposed pores in the dermal layer. Here we find circular spindle-shaped cells, which form a contractile sphincter by the aid of which the pores can be more or less closed. In Lencones which have extensive Sub-dermal cavities there are longitudinal cells of this kind in the pillars which connect the outer membrane with the body of the Sponge.

AMŒBOID CELLS.

I have met with these elements in all calcareous Sponges. They represent like those of other Sponges, the lobate Amœbæ, and move about pretty rapidly in the Gallert. I have not observed that they are packed more closely together in one part of the Sponge than in another.

They seem equally distributed. Their number is subject to great variations. I have always found more in Lencones than in other Sponges.

SEXUAL PRODUCTS.

The ova are transformed Amœboid cells which are when matured, enclosed by an Endothel. Before that they creep about, and are distinguished by their size and granular Protoplasm from ordinary wandering cells a long time before they become sessile and enclosed by Mesodermal pavement cells and so surrounded by a Follicula.

Generally four or five ova lie together in separate Follicula closely packed together and surrounded by a common Follicula in the Heterocœlia. In the Homocœla the ova remain simple and no Follicula is formed as in their higher developed relations, although also here the indifferent star-shaped cells congregate around the ripe ova.

The first stages of development are passed through within the body of the mother.

The Spermatozoa are formed in numbers within transformed Amœboid wandering cells, Spermospores, which betray their nature a long time before Spermatozoa begin to make their appearance as small dots; the nuclei are derived from the nucleus of the Spermospore by continued fission.

THE GLAND CELLS.

Similar cells as those described from a few other Sponges, and to which a secretory function is attributed, are also met with in the Calcareous Sponges.

Either single or in small bunches they are attached to the inner side of the Ectoderm of the Lencones. They are pear-shaped, and their real nature can easily be detected by the presence of large highly refractive granules in their interior. They stand vertical to the surface with which they are in connection by a slender peduncle.

SENSITIVE AND GANGLIA CELLS.

Spindle-shaped cells of the Mesoderm, which lie just below the surface, and protrude beyond the outer coating of Ectodermal pavement cells are not rare in the Heterocœla. They stand vertical to the surface, the nucleus is oval and situated in the middle of the cell. The proximal part of such a cell is often produced into a long thread, which may be ramified and often can be traced to another cell lying further down in the Mesodermal Gallert. Such spindle-shaped cells have been observed by me in clusters scattered irregularly over the surface in Leucandra saccharata Leucandra meandrina and other species. Single and also scattered irregularly, but particularly numerous in the vicinity of the pores in Leucandra conica, n. s., and Leucandra sacharata, also in Lencetta and Leucaltis. As a ring surrounding the inner wall of the conic, widening canal leading down from the pores of Sycandra arborea into the inter canals. As clusters in the same locality in Grantessa sacca, n. s. Also, in Vosmæria gracilis, n. s., and Sycandra pila, n. s. I have detected similar structures in bunches around the pores, these latter are however, slightly different from the former, and I do not like to assert their nervous nature with the same confidence as that of the former organs.

It appears from this, that sensitive cells of this kind are met with in all Heterocœla. In Homocœlia I have not found any cells which may be considered as specially sen s tive

Ganglia cells have been observed in several of the species mentioned above. They are highly colorable (particularly their nucleus) multipolar cells. In Sycandra arborea they lie between the muscular fibres of the Sphincter and the sensitive elements, just above them. In Leucandra they are often found near the base of the clusters of sensitive spindle-cells.

They are here of the same shape as in Sycandra.

Also in connection with the solitary sensitive cells of Leucandra conica solitary Ganglia cells are found. Also these seem to be of the same multipolar kind as in the former cases.

THE ECTODERM.

In all Calcareous Sponges the Ectoderm consists of simple pavement cells, which cover the outer surface, the inhalent canals and often also extend over the spicules protruding from the outer surface. No differentiation of any kind can be detected. Many of the cells are flat (on the surface) or concave (in the pore canals) or convex (on the spicules), they always represent the same simple type of low plates filled only partially with protoplasm, which surrounds the compressed nucleus and adheres as a thick plate to the outer surface. From this plate threads extend, which pervade the cell cavity.

The question whether the nervous and gland cells really are Mesodermal, as I assume, or Ectodermal, seems worth discussing.

My assumption of the Mesodermal nature of these organs is mainly based on the fact that the Ectodermal Epithelium cells never show any tendency of higher development. There exists no transition forms between the pavement cells and gland or nerve cells. Such transition forms do however exist in great quantity between these elements and the indifferent, doubtlessly mesodermal star-shaped tissue cells, from which, muscles and probably nerves have been differentiated ; whilst the gland cells may possibly be referrable to another and more recent kind of mesoderm cells, from which also the sexual cells originate the mesodermal wandering cells.